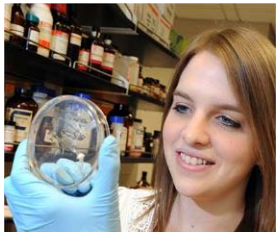
Integration of Earth Science Research and Education at UAH

Robert Griffin, UAH ATS
robert.griffin@nsstc.uah.edu | 256.961.7783

UAH

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE



By the numbers

2 SATELLITES LAUNCHED INTO SPACE

$**97**M FEDERALLY FINANCED RESEARCH & DEVELOPMENT FUNDING

$1,000,000 EARNED PER YEAR FROM INTELLECTUAL PROPERTY

12+ ON-CAMPUS RESEARCH CENTERS

Geospatial *(GIS&RS)* Education/Training

1) BS in Earth System Science
   Focus in Remote Sensing and GIS
2) MS in Earth System Science
3) JUMP Program
   Joint Undergraduate –Masters Program
4) Research Abroad Program

Applied research focus *and developing solutions for transitioning data and analyses to* ***end-users/decision-makers****, Work with external organizations, Internships/Co-Ops with private and government organizations to provide* ***real-world training***

http://nsstc.uah.edu/ess/GIS/

http://nsstc.uah.edu/ess/ESS/

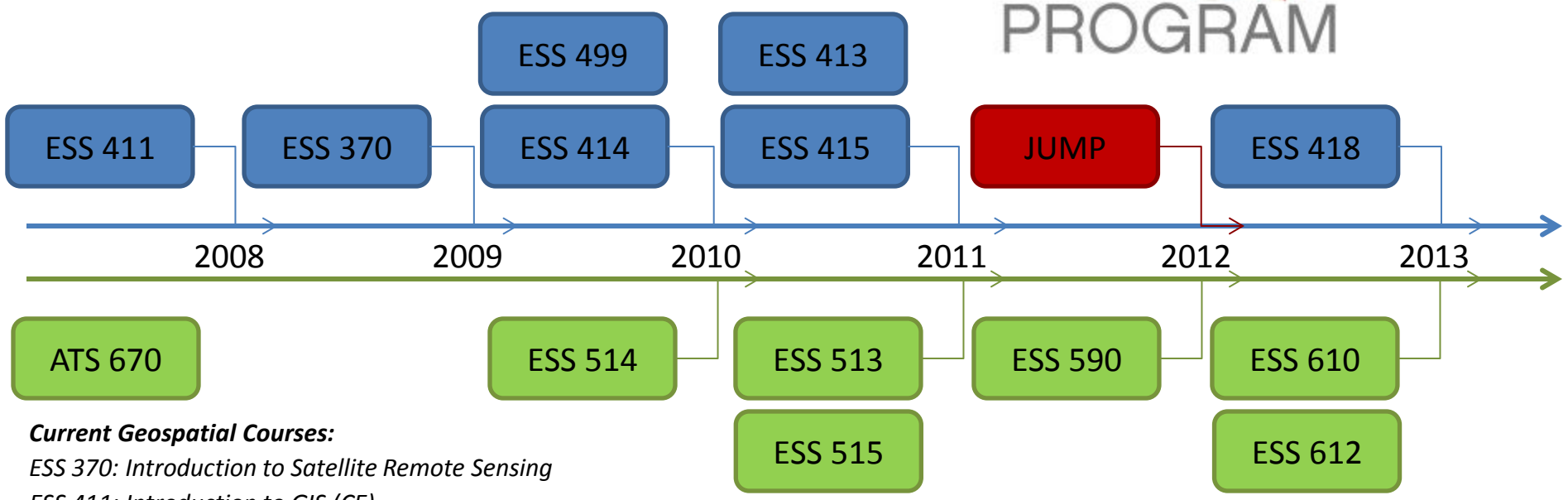
http://nsstc.uah.edu/panama/

GIS & Remote Sensing in Earth System Science *(BS/MS)*

1) Atmospheric Science
2) Atmospheric Chemistry
3) GIS & Remote Sensing
4) Earth Ecosystems
5) Hydrology
6) Human Dimensions

Declared ESS Majors (UG)
2014: 100+
ESS MS Students
2014: 15

JUMP PROGRAM



Current Geospatial Courses:
ESS 370: Introduction to Satellite Remote Sensing
ESS 411: Introduction to GIS (CE)
ESS 413/513: GIS and Image Processing
ESS 414/514: Geospatial Applications
ESS 415/515: Advanced GIS
ESS 499: Undergraduate Research Capstone
ATS 670: Satellite Remote Sensing I
ATS 680: Numerical Modeling Applications for ESS

Future Course Additions:
ESS 408/508: Python for GIS

GIS/RS Research Computing Facilities @ NSSTC

available UG/GR student facilities to conduct research, interact with peers and mentors, and “own” their research

NSSTC (Bud Cramer Hall @ UAHuntsville Campus)

25 Dell Optiplex workstations

ArcInfo 10.1 (Spatial, 3D, Network, Geostatistical)

ENVI 5.0 +IDL

Mobile ESS Lab (Dell ATG semi-rugged laptops, full GIS/IP software, Garmin handheld GPS)

used in the field in Mexico, Panama, Guatemala, Atlanta, Tennessee, Alabama

GIS & Remote Sensing Lab (NSSTC 4085)

Research Abroad Program: Panama

Climate Change & Sustainability in Latin American and the Caribbean

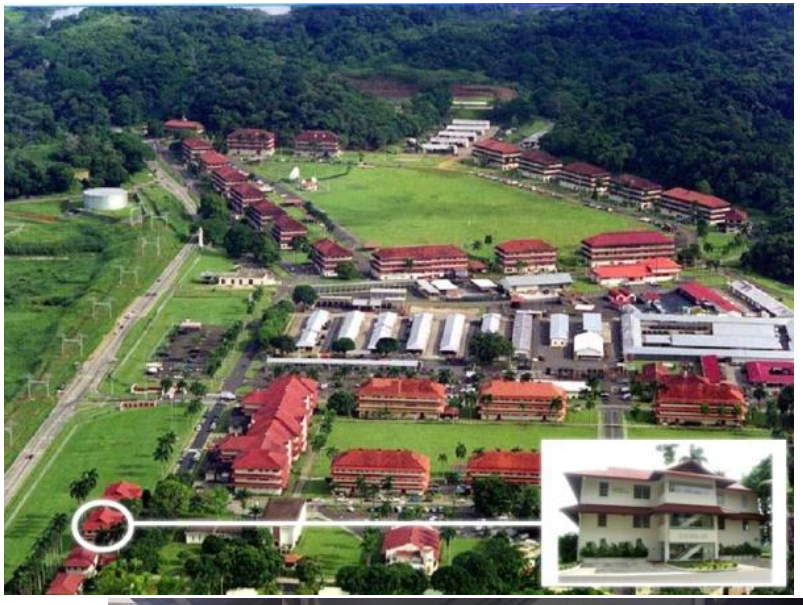
- Instruction in research design, analysis, fieldwork techniques (First **Research**/Abroad Experience)
- GIS/RS/Image Processing & policy and science of climate change/sustainability
- Instruction shared between CATHALAC and UAH scientists and faculty
- Cultural awareness through immersive activities: social events, homestays, community service

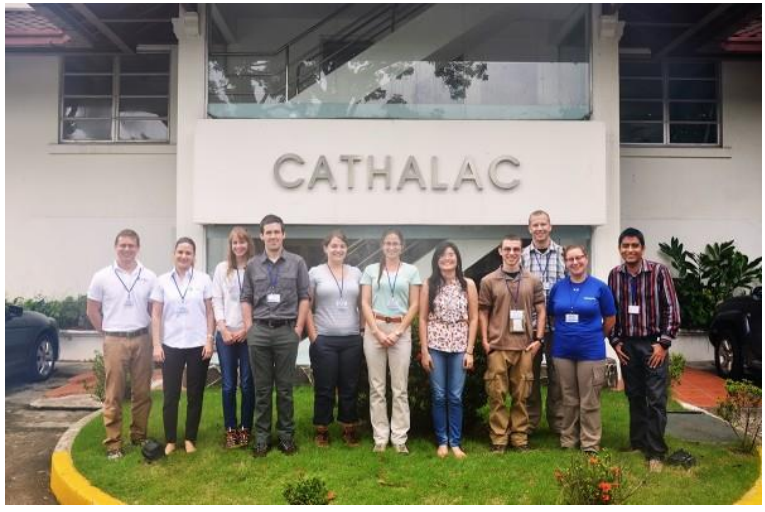
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

CATHALAC

Partner Organizations: CATHALAC

CATHALAC 20 AÑOS
SCIENCE, EDUCATION, AND POLICY FOR PEOPLE





Research Abroad: Panama

Research Projects

Evaluation of Precipitation, Temperature, and Soil Condition effects on Sugar Production at Ingenio Santa Rosa, Panama using Remote Sensing Data *(Kirsten Cooksey, David McConnell, Joshua Smith)*

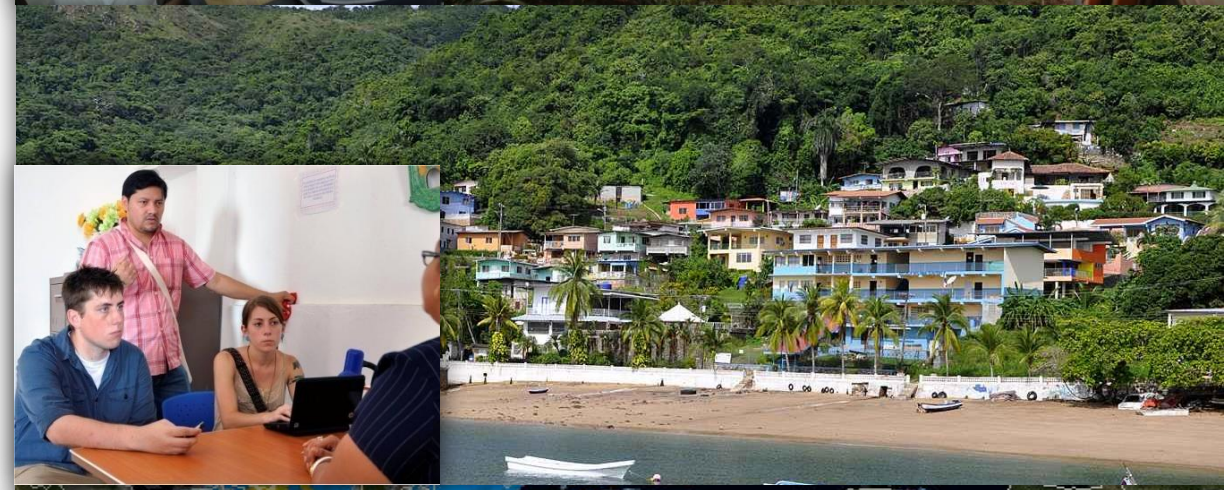
Projections on Potential Impacts of Changing Precipitation and Land Cover on Sedimentation in the Panama Canal Watershed
(Tiffany Keeton, Cory Manberg, Josh Myrick)

Developing the Hydrological Problematique of Taboga Island
(Amanda Bosserman, Jason Pounders)

Nitrogen fixing Fabaceous plants and their benefits to agriculture *(Joseph Wayman)*

Los Emberá y sus Recursos: la Vulnerabilidad de los Recursos Naturales al Cambio Climático
(Claire Herdy, Emma Norton, Nancy Pospelov)

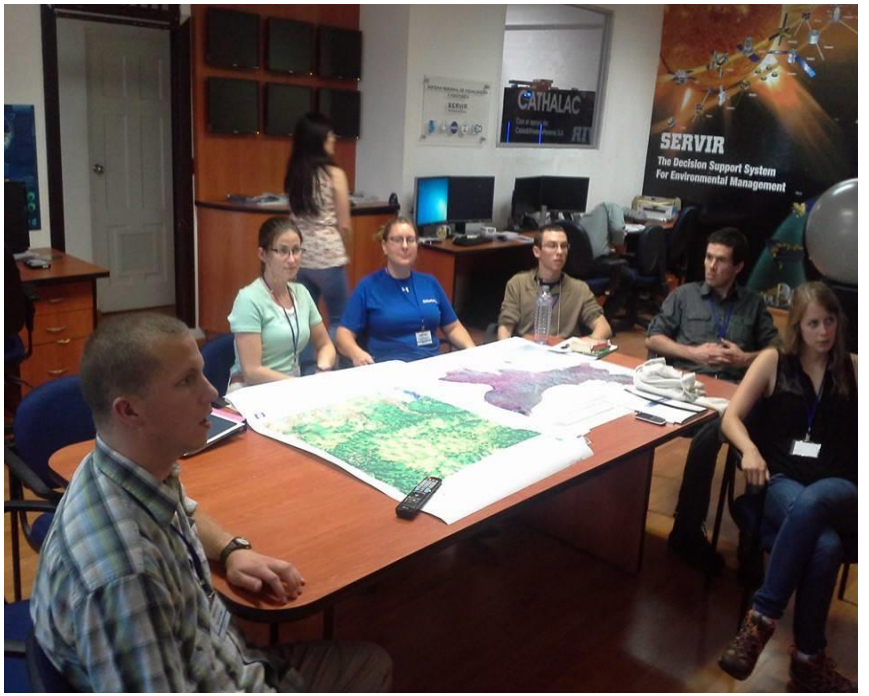
Comparison of MM5 and WRF Forecast Models, CMORPH and Hydro Estimator Satellite Estimates to Ground-Based Rain Gauge Data *(Nicole Dsouza, Melanie Phillips)*



Research Abroad Program: Panama

2014 Research Project

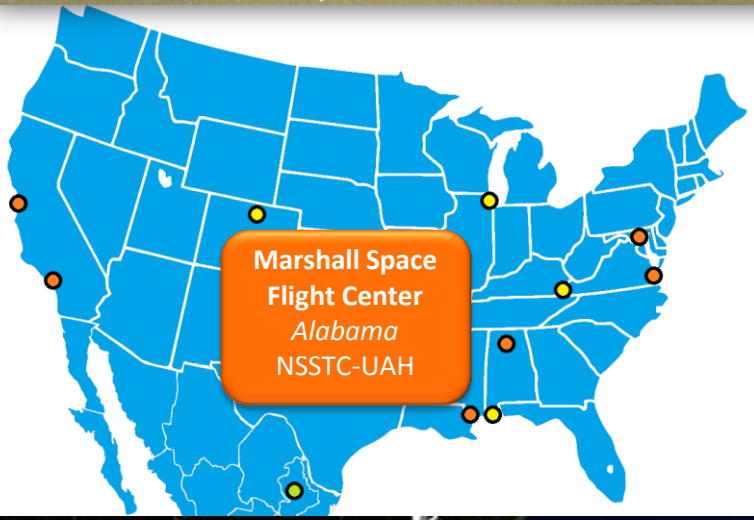
- *Adaptation to Climate Change and Water-based Community Organization*



NASA-DEVELOP Research Internships (available every semester)


MSFC-DEVELOP Team, SERVIR Student Research Lab

DEVELOP is a ***training and development internship*** enabling students and young professionals to learn about Earth science and develop prototype applications. DEVELOP addresses needs for long-term capabilities within the workforce to use Earth science results in ***decision making***. Advisors from NASA and partner organizations assist students in using NASA data in fields such as: Agriculture, Climate, ***Disasters***, ***Ecological Forecasting***, Energy, ***Health & Air Quality***, Oceans, ***Water Resources***, Weather.



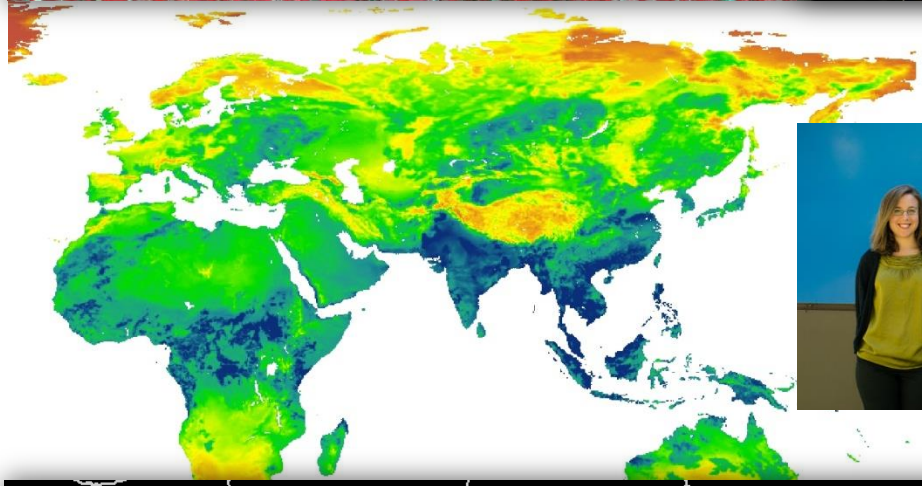
Leigh Baggett, *Center Lead*
Amberle Keith, *Co-Lead*
University of Alabama in Huntsville (ESS)
Jeff Luvall, *NASA-MSFC Science Advisor*
Rob Griffin, *UAH-ESS Project Advisor*

NASA-DEVELOP Research Internships

2011/2012 MSFC Projects Highlights

Leveraging NASA EOS to explore the environmental and economic impact of the April 27 Tornado outbreak in Alabama

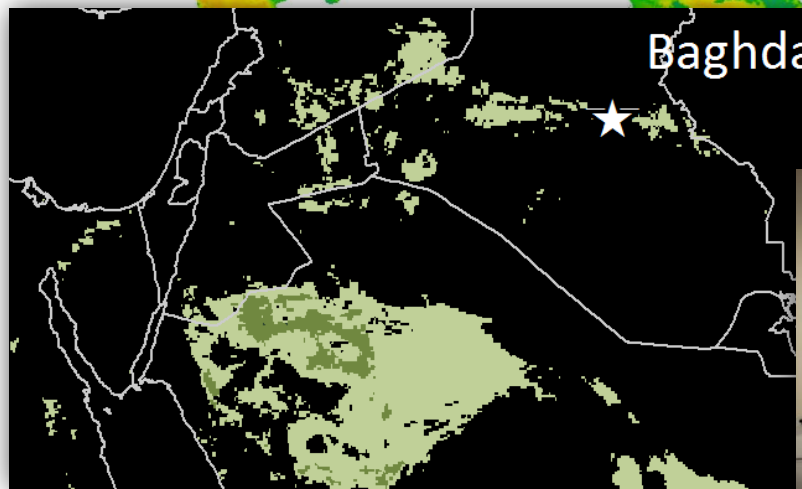
Mobile Bay Oyster Reef Habitat Analysis, Development of a Habitat Suitability Model for Mobile Bay Oyster Reefs Based on Hydrologic Models



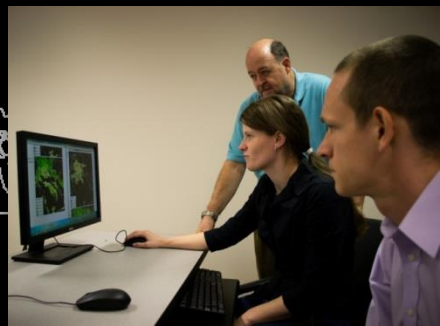
Using NASA EOS to Identify and Monitor Pathogenic Dust in the Middle East

Colombia Fire Forecasting: *Utilizing NASA EOS data for fire management in el Departamento del Valle del Cauca,Colombi*a

Nepal-Food Security: *Utilizing NASA's EOS data to research the potential effects of climate change on food security in Nepal*

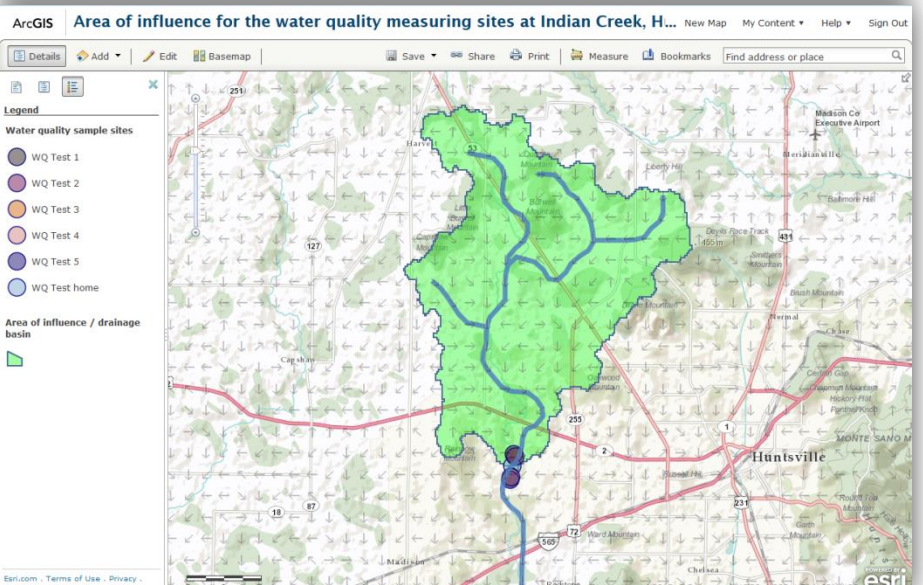


Middle East Public Health & Air Quality: *Using NASA EOS to Identify and Monitor Pathogenic Dust in the Middle East*



Southeast Ecological Forecasting: *Using NASA Earth Observation (EOS) satellites for large-scale mapping of the longleaf pine (Pinus palustris) forest ecosystem.*

Geographic Information Systems in Advanced Placement Environmental Science (GIS in APES)



Community and high school outreach via directed STEM teaching by MS graduate students in Earth System Science (ESS 490ST) and Civil Engineering.

- GIS as a tool for **water resources/pollution issues** at home and abroad
- The many applications of GIS and remote sensing
- Putting hydrology concepts into practice with geospatial data
- Integrated GIS (field & lab) tie directly into APES learning goals and labs

- Hands-on introduction to GIS using **ArcGIS Explorer**
- Mark **water quality** testing sites using Garmin GPS
- Advanced junior and senior level high school students

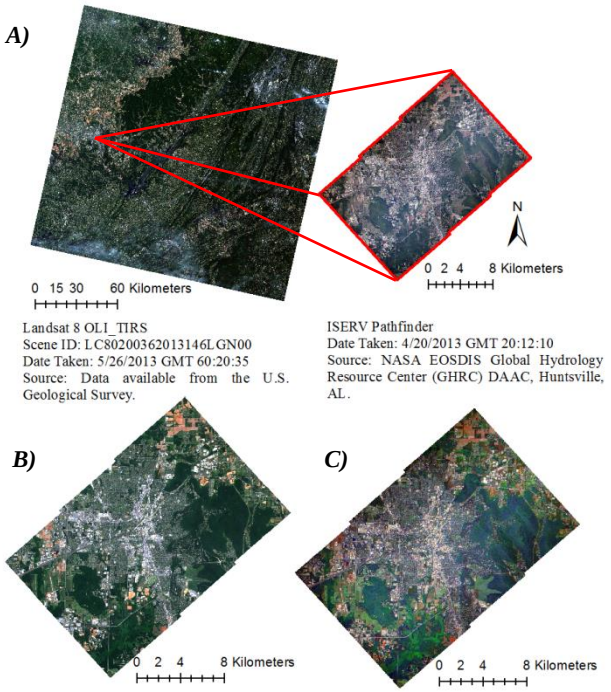
Eric R. Anderson
M.S. Candidate, Earth System Science
UAHuntsville
Ben Johnston
AP Envi. Sci., Bob Jones HS, Madison

Using ISERV Imagery to Pan Sharpen Landsat 8 Spectral Data: A Vegetation Analysis of Huntsville AL

Jeanné le Roux, Dr. Robert Griffin, Eric Anderson
University of Alabama Huntsville Earth System Science Program

Introduction and Background

The ISS SERVIR Environmental Research and Visualization System (ISERV) is a payload on board the International Space Station (ISS). ISERV is a telescopic imager which takes rapid, automated, high-resolution photos of the Earth from space. The purpose of this research was to test the feasibility of pan-sharpening Landsat 8 near-infrared data with ISERV data in order to run a normalized difference vegetation index (NDVI) on the resulting image. This new image was compared to an NDVI of a Landsat 8 image pan-sharpened with its own panchromatic band. Feature extraction was performed to extract vegetation features from both results and compared. The ISERV result was chosen for display.

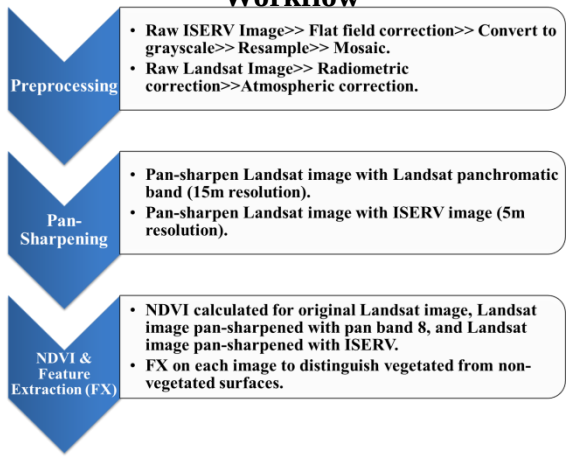


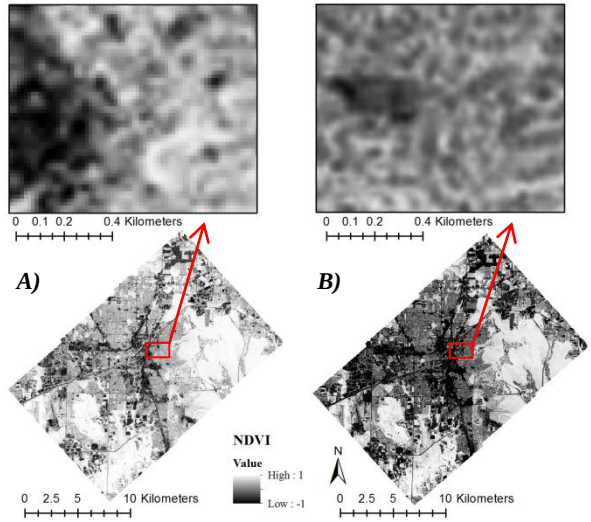
Above: A) Area of Study over Huntsville, AL. B) Landsat image over Huntsville pan-sharpened with Landsat 8's panchromatic band (15 x 15 m resolution). C) Landsat image pan-sharpened with ISERV (5 x 5 m resolution).

Purpose

ISERV images only encompass the visible spectrum with red, green, and blue bands, making it impossible to run a NDVI or similar analysis without the introduction of NIR data. Fusing the ISERV imagery with a Landsat 8 image introduced NIR data while enhancing Landsat 8's spatial resolution.

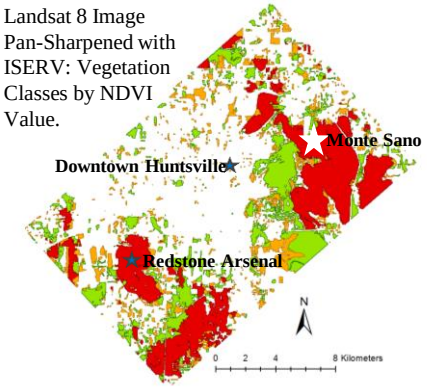
Workflow





Above: A) 1:3,000 zoom above the Landsat 8 scene pan-sharpened with its panchromatic band. B) 1:3,000 zoom above an NDVI of the Landsat 8 scene pan-sharpened with ISERV. NDVI values closer to 1 represent denser, healthier vegetation. Image B was chosen for feature extraction due to greater heterogeneity

Landsat 8 Image Pan-Sharpened with ISERV: Vegetation Classes by NDVI Value.



Dense = 0.720 – 1.000
Moderate = 0.588 – 0.720
Sparse = 0.450-0.588

Conclusion

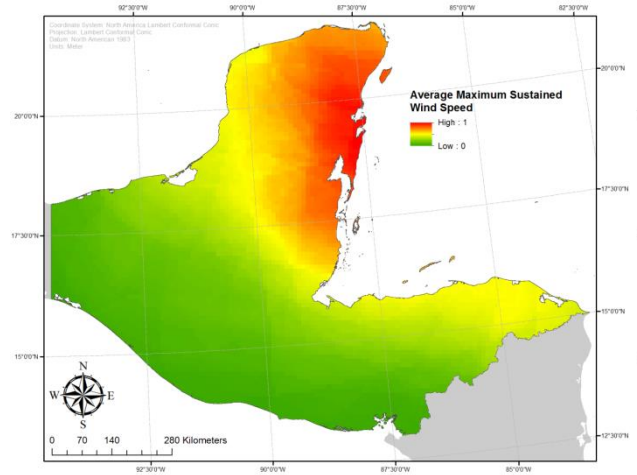
It is evident from this research that it is feasible to pan-sharpen Landsat 8 imagery with ISERV images. This opens up the possibility to conduct various image analyses, such as NDVI illustrated here, through utilizing ISERV's high resolution data. Future research can investigate statistical features of pan-sharpening with ISERV as well as additional applications applicable via this technique. Furthermore, this technique can prove useful for end users of ISERV including NASA- SERVIR scientists.

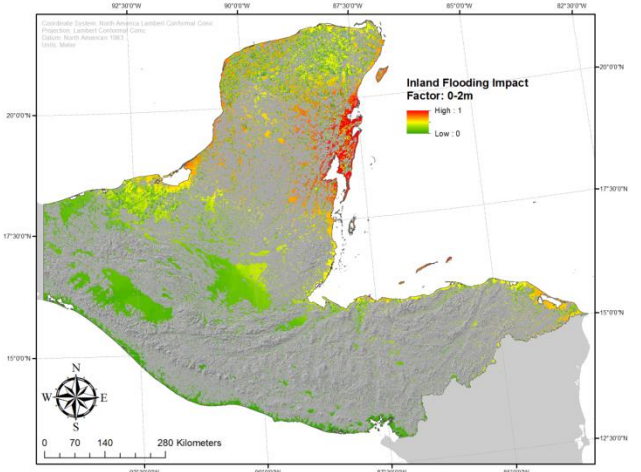
Acknowledgements

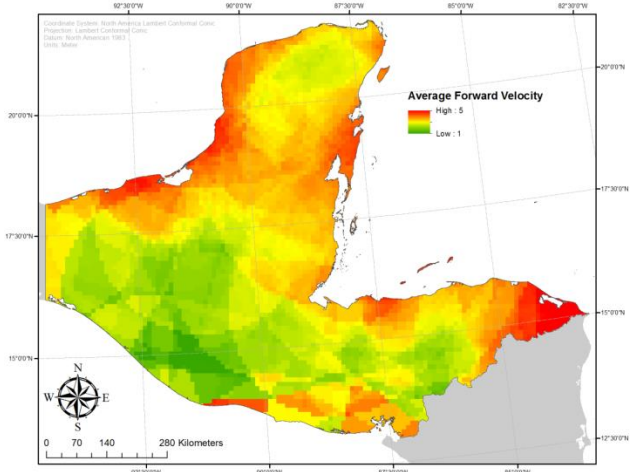
I would like to thank Dr. Robert Griffin, Eric Anderson, Dan Irwin, Burgess Howell, Jagan Ranganathan, the NASA-SERVIR program, and Dr. Bernhard Vogler. This research was funded by the RCEU Program with funds provided by: the UAH President/Provosts Office, the UAH Vice President of Research, the UAH Chemistry Department, and the Alabama Space Grant Consortium.

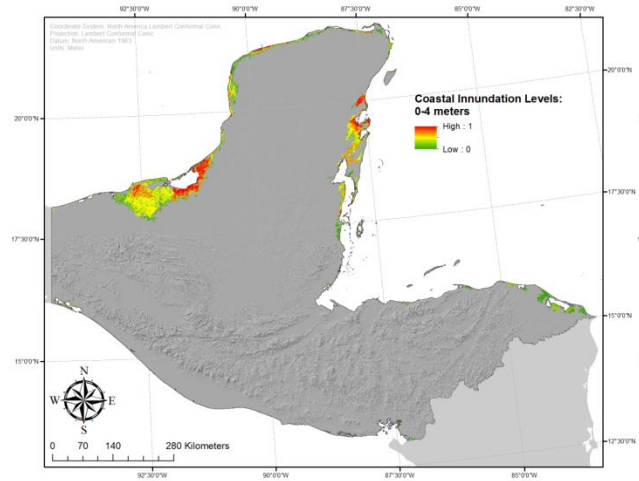
Hurricane Impacts on Society, Risk Factors (Yucatan)

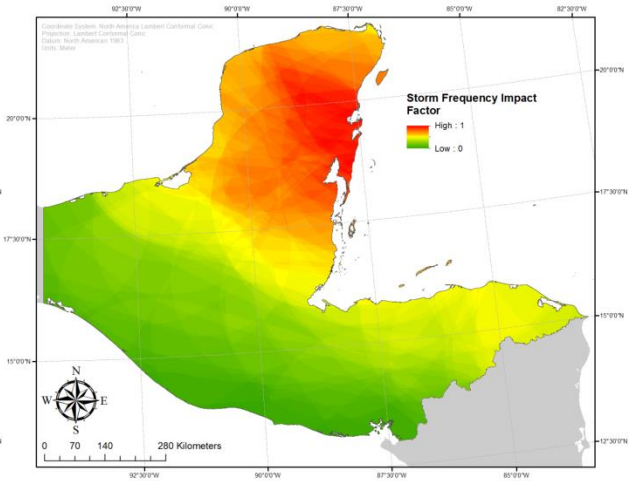
A. Weigel, R. Griffin

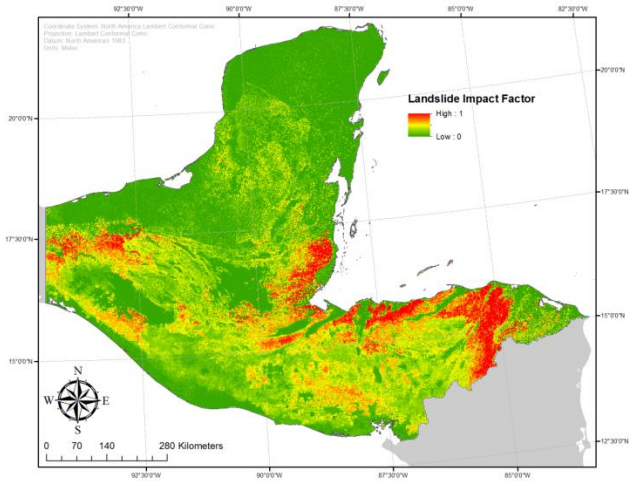








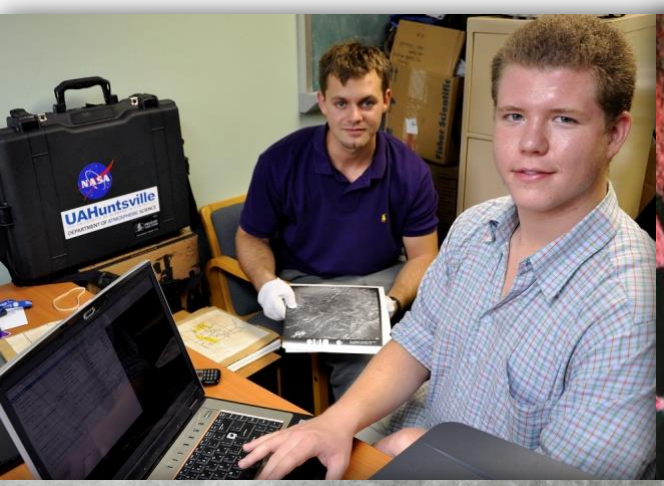


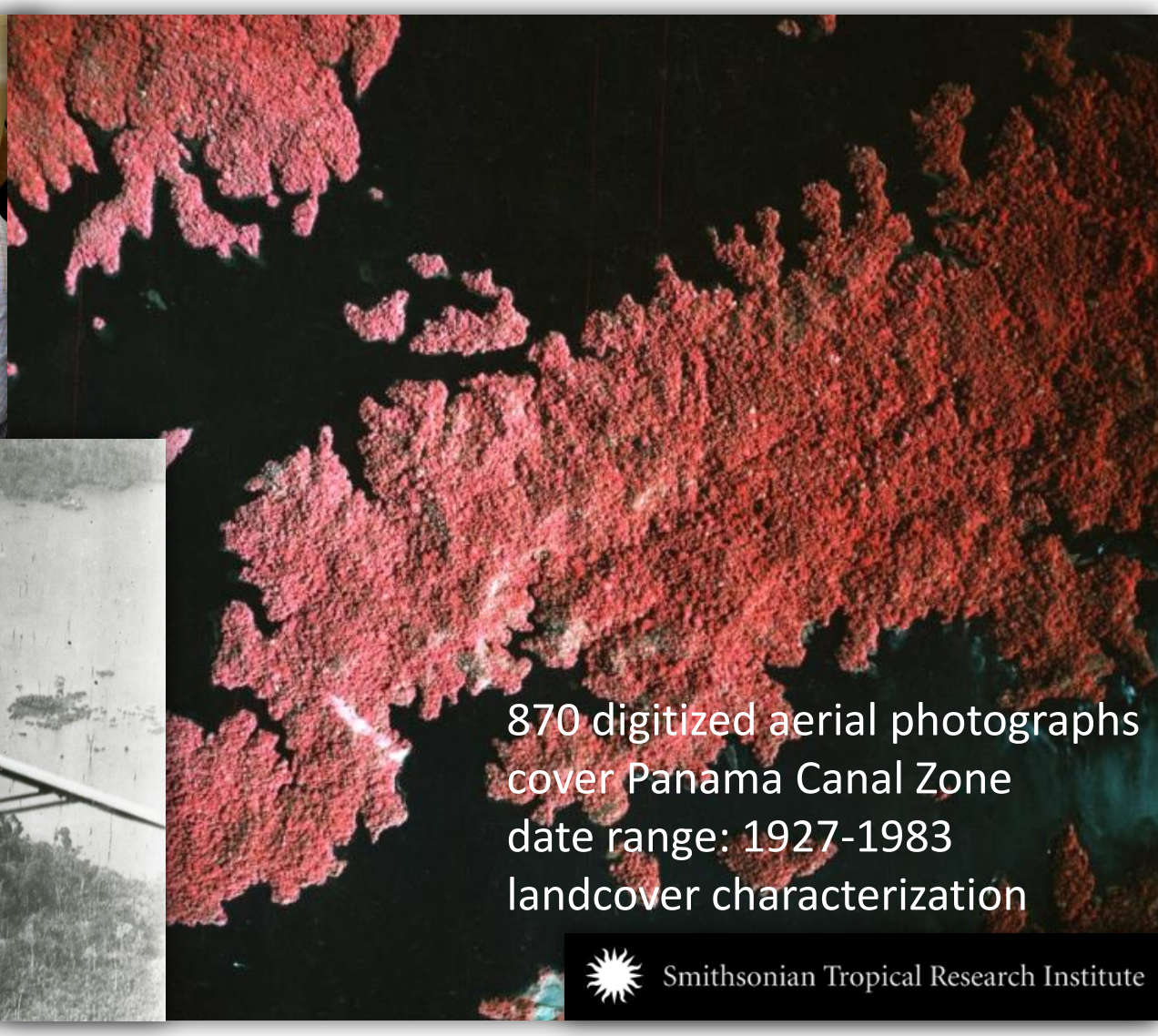


- IUC GRA (A. Weigel) with Baron Services Inc., Huntsville, AL

Panama Canal Zone Historical Landcover Change

Investigation of Land Cover Change within the Panama Canal Watershed through the Interpretation of Aerial Photographs
(S. Christopher, R. Griffin, C. Calamaio, Z. Langford)

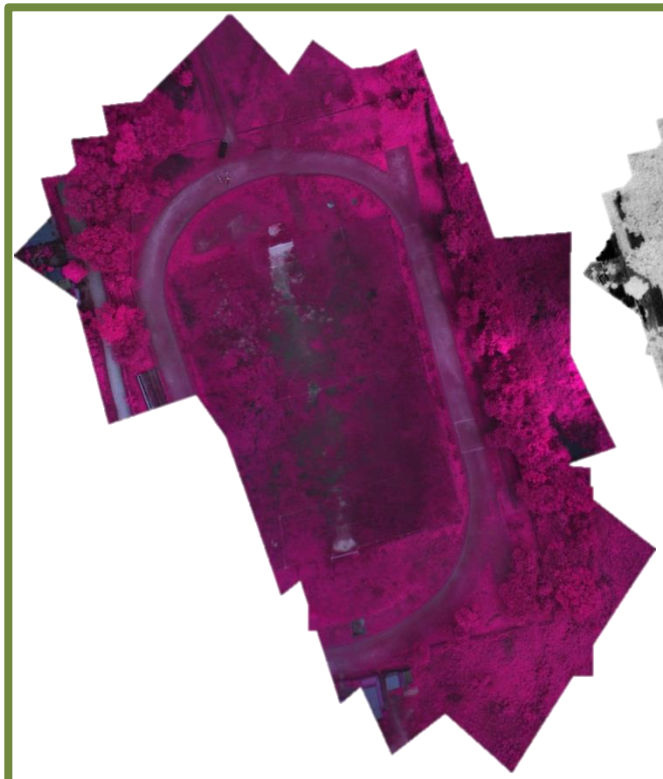


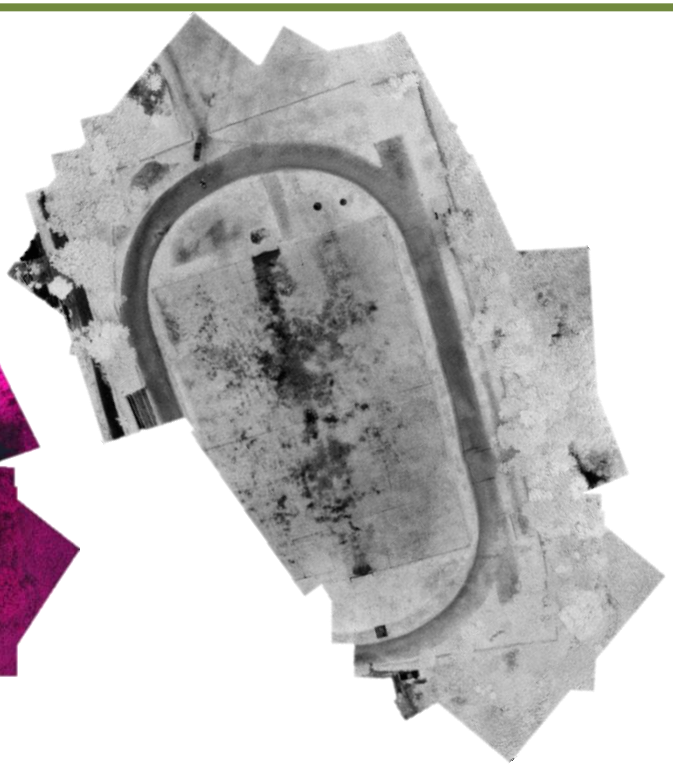


870 digitized aerial photographs
cover Panama Canal Zone
date range: 1927-1983
landcover characterization

Smithsonian Tropical Research Institute

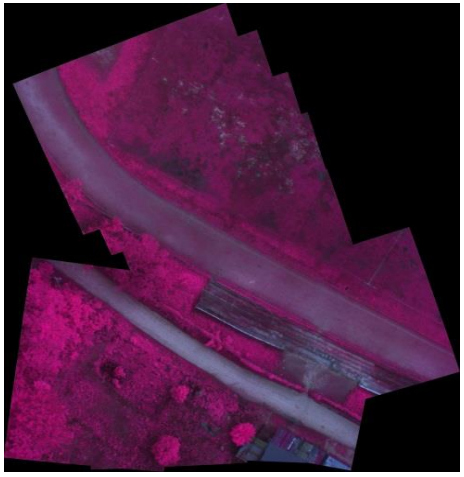
Complejo Maya, Santa Elena, Guatemala
UAH Amateur RC Research Trip – 16 – 20 December 2013



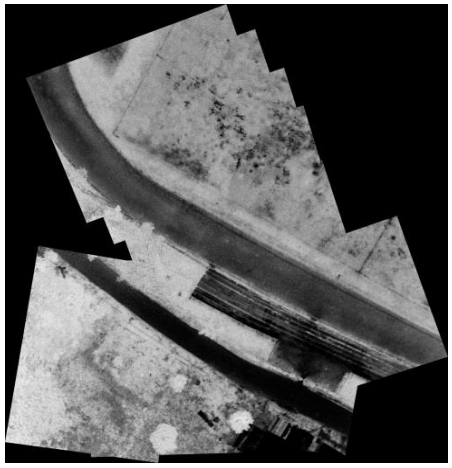


TetraCam ADC Lite

- 0.20 kg
- Agricultural Camera (3.2 MP)
- Red, green, and NIR
- New IDL Lab for image processing
- 3D Printed Mount



False Color (NRG)



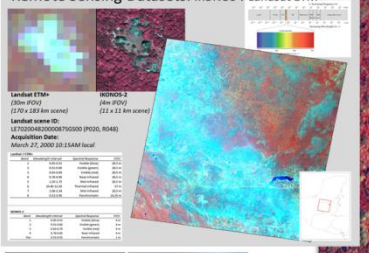
NDVI

Remote Sensing and Space Archaeology: *Deforestation, Climate, and Human Response*

Department of Atmospheric Science, University of Alabama in Huntsville (sever@nsstc.uah.edu)

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Remote Sensing Datasets: *IKONOS v Landsat ETM+*



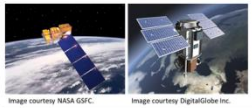
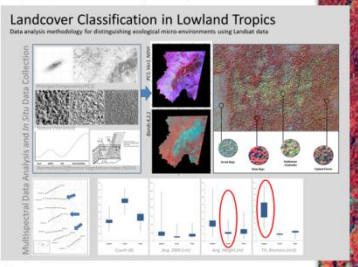


Image courtesy NASA GSFC.

Image courtesy DigitalGlobe Inc.

Landcover Classification in Lowland Tropics

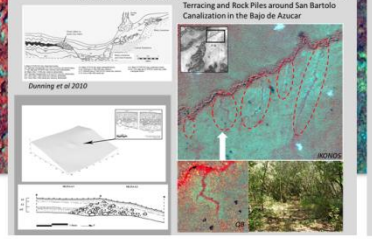
Data analysis methodology for distinguishing ecological micro-environments using Landsat data



References:
"Agricultural Landscapes, Deforestation, and Drought Severity." Robert Griffin, Thomas Sever, Robert Oglesby, and U. Nair. In "The Great Maya Droughts in Cultural Context". Gyles Iannone, editor. Colorado Press, in press.
"The Collapse of the Maya: Could Deforestation have Contributed?" Robert J. Oglesby, Thomas L. Sever, William Saturno, David J. Erickson and J. Sridhar. Journal of Geophysical Research. 2010.
"Human-induced Climate Variability upon the Ancient Maya Landscape." Thomas L. Sever, Robert Griffin, U. Nair, and M. Welch. Paper presented at the Society of American Archaeology, Atlanta GA and published in Ancient Mesoamerica 2008.
"Putting Us on the Map: Remote Sensing Investigation of the Ancient Maya Landscape." William Saturno, Thomas L. Sever, Daniel E. Irwin, and Burgess Howell. In Remote Sensing in Archaeology. Edited by James Wiseman and Farouk El-Baz. Springer, New York. 2007.
"Regional Scale Landscape Archaeology: 21st Century Remote Sensing Technology and the Ancient Maya." William A. Saturno, Thomas L. Sever, Daniel E. Irwin and Burgess F. Howell. 3rd edition, Volume 5: Chapter 8-8. edited by Merrill Kidd and Jim Hipple, John Wiley & Sons, Hoboken, NJ 07030-5774. 2006.
"Landscape Archaeology: Remote Sensing Investigation of the Ancient Maya in the Peten Rainforest of Guatemala." Sever, T.L. and D.E. Irwin. In Ancient Mesoamerica, Vol. 14, No. 1, pp. 113-122. 2003.
"Satellite Remote Sensing and Current Social Phenomena upon the Landscape, Peten, Guatemala." Special Publication of the National Academy of Sciences/National Research Council on "Peace and Plants: Linking Resource Science and Social Science". National Academy Press, May 1998.
"The Carrying Capacity of Ancient Maya Swidden Maize Cultivation: A Case Study in the Region around San Bartolo, Peten, Guatemala" 2012. Robert Griffin. Unpublished PhD Dissertation, Pennsylvania State University, Department of Anthropology.

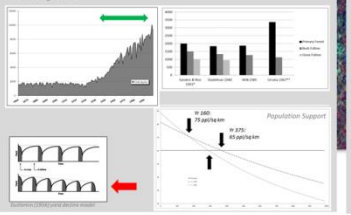
Intensive Agriculture in Northern Guatemala

Terracing and Rock Piles around San Bartolo
Canalization in the Bajo de Azucar



Yield Model: Long-Term Agricultural Decline

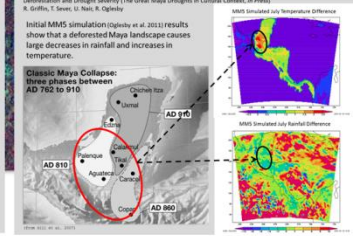
carrying capacities, or the number of people an environment can support, are often discussed for static points in time (at the initiation of a particular agricultural land use practice), but evidence suggests below-replacement fallows decrease yields over the longue duree

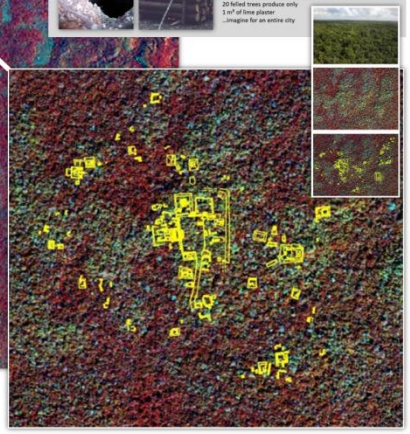


Paleoclimate Models and Ancient Land Cover

Deforestation and Drought Severity (The Great Maya Droughts in Cultural Context, in Press)
R. Griffin, T. Sever, U. Nair, R. Oglesby

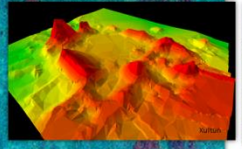
Initial MM5 simulation (Oglesby et al. 2011) results show that a deforested Maya landscape causes large decreases in rainfall and increases in temperature.





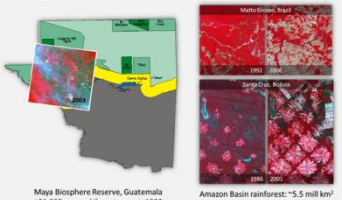
Lime plaster production for Maya architecture

Quantification of Lime Plaster Application and Remote Sensing Validation of Prehistoric Settlement Patterns
NASA ROSES Space Archaeology/NSF Archaeology R. Griffin, T. Sever, W. Saturno, N. Dunning



Modern Deforestation: Central & South America

cattle ranching, slash-and-burn/industrial agriculture, fuelwood collection, road construction & urban development



Maya Biosphere Reserve, Guatemala
~21,000 square kilometers, est. 1990
Rainforest Alliance: "15% forest loss"

Amazon Basin rainforest: ~5.5 mill km²
Brazil, Peru, Colombia, Bolivia
since 1990, ~11% forest loss

Angkor Wat, Cambodia: Deforestation & Siltation

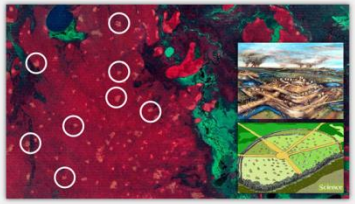
ancient canal systems, rural settlements, and deforestation (D. Evans, T. Sever, W. Saturno)

Ancient *Moche* on the Desert Coast of Peru

Adaptation to desertification, environmental change, and El Nino vis-à-vis State Irrigation Schemes
NSF-Archaeology/NASA ROSES Space Archaeology T. Sever, R. Griffin, J. Quilter, W. Saturno, LI. Castillo

Hidden Cities in the Bolivian Amazon

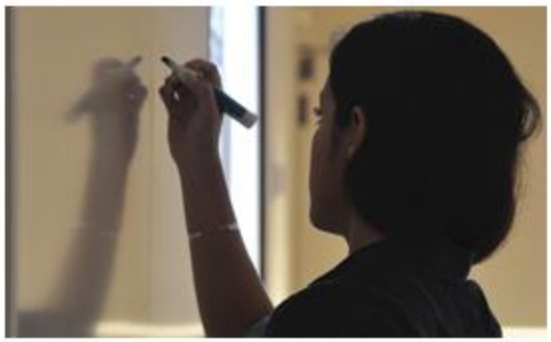
NSF-Archaeology/NASA ROSES Space Archaeology T. Sever, C. Erickson, W. Saturno, R. Griffin



Sudan Deforestation (UNEP 2007)

SERVIR member state, environmental monitoring, adaptation to environmental pressures

Student Research/Training Involvement & Successes



Student-Led Training Events
Hyperspectral Image Analysis Workshop *(Africa Flores)*

Student Research Presentations
DEVELOP Internship Final Results Presentations *(Kevin Cowart, Brad Barrick)*

Conferences Student Participation & Outreach
IAC 2012, ESRI 2012